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DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Md. 20084

COMPARATIVE ANALYSIS OF THE AMPHIBIOUS LIFT COMPUTATION MODELS MAGTF AND TUMS

by

Perry L. Price

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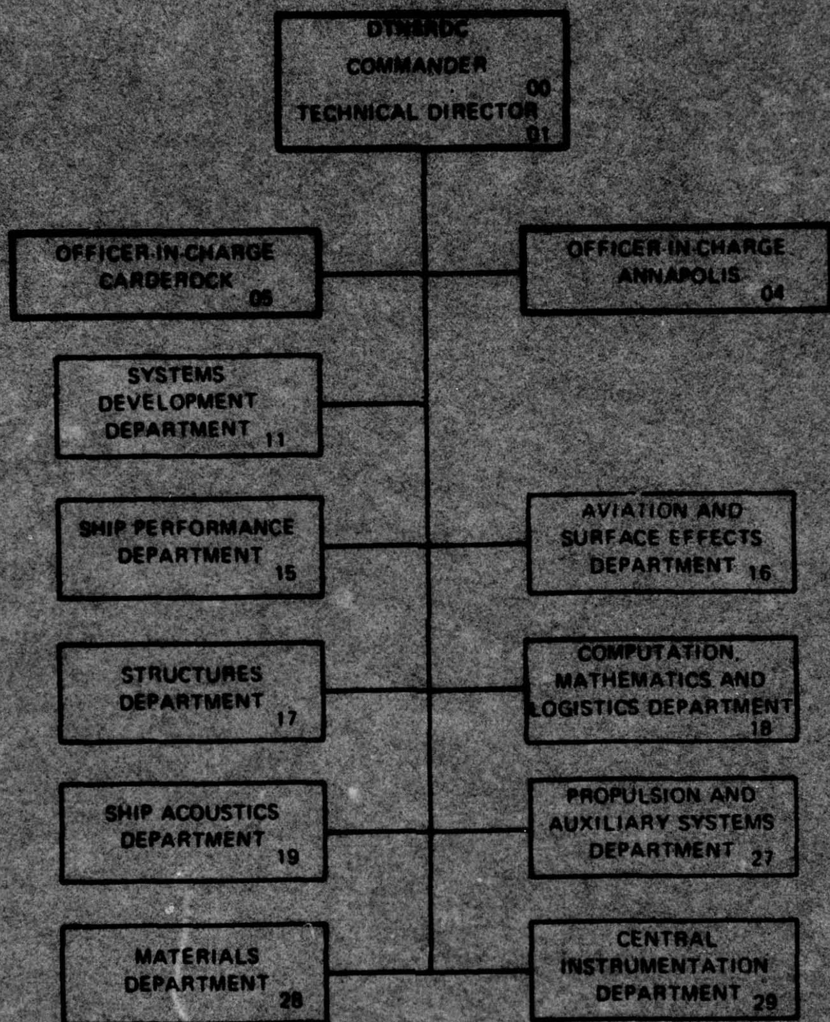

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A comparative analysis has been conducted of the capabilities and limitations of the two computer models "Marine Air Ground Task Force Lift Requirements and Logistics Planning Factors Model (MAGTF) (1975-1985)" and "Type Unit Mobility Statistics (TUMS) Model" in light of the Marine Corps' requirement for a computerized amphibious lift computation capability. The comparative analysis considered seven individual Marine Corps units and a Marine Amphibious Force (MAF) for comparison of lift computations and by the two models.

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A comparative analysis has been conducted of the capabilities and limitations of the two computer models "Marine Air Ground Task Force Lift Requirements and Logistics Planning Factors Model (MAGTF) (1975-1985)" and "Type Unit Mobility Statistics (TUMS) Model" in light of the Marine Corps' requirement for a computerized amphibious lift computation capability. The comparative analysis considered seven individual Marine Corps units and a Marine Amphibious Force (MAF) for comparison of lift computations made by the two models.

The study concludes that both models in their present configurations have major shortcomings and that neither model alone could satisfy the requirements presently being satisfied through use of both. The study also concludes that MAGTF has the greater potential for modification to meet the current requirements for a computerized lift computation capability.

SECTION 1
INTRODUCTION

1.1 BACKGROUND

In September 1971, Headquarters Marine Corps (HQMC) issued a project directive to Stanford Research Institute (SRI) to develop a computer model for computing amphibious lift requirements. This project directive resulted when HQMC found that it needed a capability for quick update of Marine Amphibious Force (MAF) lift requirements. This need became apparent during the 1970 Marine Corps update of its expression of amphibious lift to the Navy. The lift expression is the Commandant of the Marine Corps' (CMC) formal statement to the Chief of Naval Operations of the Marine Corps lift requirement for use in determining amphibious shipping needs for all contingency operations. In addition, there are two other requirements for a capability to produce lift data rapidly for standard and task-organized Marine Corps units. First, the Joint Chiefs of Staff (JCS) Joint Operations Planning System (JOPS)* requires each service to compile transportation data for movement planning and to submit these data quarterly to the JCS Type Unit Characteristics (TUCHA) file. Second, the Fleet Marine Force (FMF) commanders were required to submit logistics information in the format of the JOPS automatic data processing (ADP) system if so tasked by their respective Commanders in Chief (CINCLANT or CINCPAC). A common feature of these requirements was that they could be satisfied by data extracted from the same data base if the data base was suitably constructed. The SRI project directive was issued to establish this data base and develop the requisite computer system.

Considerable delays were experienced in completing the project. When it became apparent that the completion date for the SRI model was moving farther and farther into the future, HQMC realized it needed an interim capability to satisfy the requirement for lift computation

* Joint Operations Planning System (JOPS) is an Automatic Data Processing (ADP) supported system applied by unified commands and unified command components to develop and analyze operation plans; applied by JCS to accomplish plan review.

b. Card punched Type Unit Data (TUCHA) records (F1, F2, and F3 cards), defining notional type unit movement characteristics

until the SRI model was on line. The SRI model (Marine Corps Air Ground Task Force Lift Requirements and Logistics Planning Model (1975-1985)) is referred to as the MAGTF model in this report.

The most promising means of developing this interim capability resided in the FMFLANT. FMFLANT had an internal computer model known as the Logistics Planning Model which had very limited capability in terms of satisfying the requirement of the JOPS ADP system but provided a good structure from which the needed capability could be developed. FMFPAC has the same need for generating data for the JOPS ADP system but it would have faced greater difficulties than FMFLANT in developing an interim capability. It recommended that FMFLANT take the lead in developing the capability to generate data for the JCS TUCHA file.

FMFLANT Force Staff Order 3020.1 was issued on 5 February 1974 establishing a Joint Operations Planning System (JOPS) Coordinator and a JOPS Working Group within Headquarters, Fleet Marine Force, Atlantic. This order pointed out FMFLANT's requirements to provide input in support of the JOPS ADP program to both CMC and CINCLANT. It stated that the purpose of the JOPS coordinator and the JOPS working group was to respond to those requirements.

The JOPS coordinator and his working group developed a model capable of producing lift data in the formats required by the JCS JOPS ADP system. It was ready for use in eleven months. The model is known as the Type Unit Mobility Statistics (TUMS) System. Because MAGTF was still not available at this time, HQMC decided to use the TUMS model to produce the initial data submission to the TUCHA file. This data submission was accomplished in December 1974.

In January 1975, MAGTF was installed on the HQMC IBM 360/65 computer. Efforts were initated to use MAGTF as the source model for updating the Marine Corps expression of amphibious lift requirements.

Now the Marine Corps had two computer models capable of satisfying its requirements for both joint planning and the expression of lift requirements for notional units.* The two models produced similar,

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* Notional units are theoretical or average units used in requirements planning.

but not identical, data. Because either of the two models could be used to satisfy HQMC requirements for lift data, the two model were considered to be competing.

The maintenance and operation of two models for rapidly computing lift data was redundant in regard to the Marine Corps' requirement for the capability to produce expressions of lift requirements. Therefore, the Marine Corps requested an independent evaluation of the two models. The David W. Taylor Naval Ship Research and Development Center was tasked to perform the comparative analysis. This report documents the results of that analysis.

1.2 OBJECTIVES

The objectives of the study are:

a. To compare the capabilities and limitations of the MAGTF and TUMS computer models, in view of the present and projected needs of the Marine Corps for automated lift/logistics computation capabilities, and the relative costs involved.

b. To identify the limitations that preclude one model from providing the capabilities presently provided by both and to state the major revisions and estimated cost of making each model capable of satisfying the total requirements.

1.3 SCOPE

This study compares the models from the standpoint of how well they satisfy the requirements of the Marine Corps for lift data. The purely technical computer science aspects of the models such as tape usage, disk usage, and input-output techniques are not within the scope of this study.

1.4 APPROACH

The approach used in this study was first to develop an understanding of the capabilities of the two models, MAGTF and TUMS, and then to assess the requirements of the Marine Corps for amphibious lift data.

TUMS was developed and is maintained as an in-house system. To give the TUMS model the same flexibility as MAGTF in computing DOS would consti-

Following this the capabilities of the two models were assessed in light of the Marine Corps requirements for amphibious lift computations. The limitations of the models were then identified and the conclusions and recommendations stated.

Precise cost estimates for recommended modifications were not made because of the many factors which had to be assessed (such as who will perform the modification, their familiarity with the models and the Marine Corps requirements for Lift Computations, etc.) before reliable estimates could be presented. Relative estimates of the level of effort required to modify both systems were made and, on the basis of a comparison of those estimates, the relative costs of modifying the two models are discussed.

4.4 SELECTIVE ELIMINATION OF EQUIPMENT OR MAJOR MATERIAL ON THE BASIS

SECTION 2
THE TYPE UNIT MOBILITY STATISTICS (TUMS) MODEL

2.1 TUMS SYSTEM DESCRIPTION

TUMS is a management information system whose purpose is to automate the management of information describing transportation requirements of military organizations identified by Unit Type Codes (UTC).* TUMS is operational on the IBM 360/30 computer system resident at HQ FMFLANT. The TUMS system has been used successfully to develop Marine Corps data for submission to the JCS TUCHA file, to support OPLAN development, and in crisis management.

TUMS produces 12 major reports which are described in the TUMS User's Manual.[1] Included are samples of each report. Descriptions of these reports are reproduced from the TUMS manual and are included in Appendix A. The reports can be obtained for an individual unit or for an aggregation of units (referred to as a "force"). The data base from which these reports are produced consists of three separate data files which are described as follows:

a. The MIC (Master Item Characteristics) file contains characteristics of every major item of equipment or supply which could be found in any unit of the data base. This file contains the characteristics of more than 2000 items. The following major data elements describe each item:

   (1) System or Item Identification - Item identifications found in the Table of Authorized Material (TAM) for those items listed in the TAM. Navy items are not listed in the TAM, but are identified by numbers chosen by the TUMS system developers. These numbers are similar to TAM numbers and are referred to as "Pseudo TAM numbers."

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*. The UTC is a standard coded representation of logically similar kinds of military organization established by the Joint Chiefs of Staff. The term "organization" is defined to include those things commonly called establishment, activity, unit, enterprise, institution, company, corporation, agency, bureau, office, group, or committee.

1.."Type Unit Mobility Statistics (TUMS)", Users Manual, Fleet Marine Force Document 4600 M-01, 15 January 1976.

(2) Supply Class and Supply Subclass.

(3) National Stock Numbers.

(4) Description - Nomenclature of item using up to 30 characters (i.e., a red smoke hand grenade is described as GREN HAND SMOKE RED).

(5) Combat Active Factor - Expected 30-day replacement requirement under combat situations.

(6) Assault Indicator - Those items computed at double the combat action rate during the first 30 days of combat due to anticipated high loss.

(7) Unit or Standard Package.

(8) Package Weight.

(9) Package Cube.

(10) Square Stow Indicator - Identification of an item as a vehicle or one which is stored like a vehicle (square stow).

(11) Length - to nearest inch.

(12) Width - to nearest inch.

(13) Height - to nearest inch.

(14) Square Feet - square feet of stowage.

(15) Cubic Feet of Vehicles.

(16) Weight - Weight of vehicle to nearest pound for cargo carrying vehicles.

(17) Cargo Cube Capacity - Cargo capacity in cubic feet for cargo carrying vehicles.

(18) Cargo Weight Capacity - Cargo capacity in pounds for cargo carrying vehicles.

(19) Mobile Load Indicator - Indicates whether an item is normally loaded on a vehicle of the same unit.

(20) Fuel Code - Indicates fuel requirements.

(21) Fuel Consumption Rate - Normal daily fuel consumption rate in gallons per day for primary fuel.

(22) Secondary Fuel Code - Used only if item has more than one primary engine (e.g., bath unit).

(23) Secondary Fuel Consumption Rate - Normal daily fuel consumption rate in gallons per day.

(24) Vehicle Code - Identifies item as a vehicle, aircraft or floating craft.

(25) Weapons Code - One of 99 weapon codes (e.g., rifle, 5.56mm M16A1, is described by weapon code 46).

b. The MUE (Master Unit Equipment) file contains personnel totals and equipment density for each master unit in the TUMS data base.

(1) Unit Type Code (UTC) - The standard JCS codes for military organizations

(2) Personnel Record Indicator - The number of officers, staff NCO's (E-6 and above), and enlisted Personnel (E-5 and below).

(3) System Identifier - End items and the quantity of each held by each type unit.

c. The CVF (Class Five Factor) file contains ammunition descriptions, packaging, and usage factors associated with each weapon code identified in the MIC file. This file contains the ammunition requirements identified by the Department of Defense Ammunition Codes (DODAC) as well as nomenclature. Other data included are the first 30-day requirement, 30-day sustaining resupply rate, quantity of ammunition per standard package, and the weight and cube per standard package.

In order to generate TUMS reports, the user must define the units for which reports are desired and the type of reports (printed, cards, or magnetic tapes). The format for the input data is well defined. Several examples are included in the TUMS User's Manual.

2.2 TUMS DATA BASE

The TUMS data base consists of the MIC, MUE, and CVF data files. The source data for these files come from major subordinate commands of the Fleet Marine Force Atlantic (FMFLANT) and from replacement, consumption, and expenditure factors published in several documents, such as the TAM, Table of Manpower Requirements (TMR), Table of Organization (TO), Table of Equipment (TE), Marine Corps Orders, etc. As in any management information system, the output of the system is no more accurate than the data base. The TUMS system manager, therefore, developed a validation procedure for insuring the accuracy of the movement characteristics data of the TUMS data base.

The TUMS data base validatation procedure is published in a FORCE Bulletin which additionally tasks the major subordinate commanders to conduct the validation. Initially, certain inputs were supplied by the major subordinate commanders to establish the data base. Periodic updates of the data base are conducted in which the major subordinate commanders are supplied with TUMS reports of their subordinate units. The major subordinate commanders are tasked to determine the validity of these reports and make corrections on forms supplied for this purpose.

The question of whether the TUMS data base is validated against what a unit actually has on hand or against what it is authorized to have was the focus of much attention during this analysis. In response to that question, the JOPS coordinator* said that the "TUMS-produced movement characteristics data reports are based on authorized personnel and allowance and not on what is actually on hand." He also stated that "when Marine Corps-units are alerted for movement, they are issued equipment and assigned personnel to fill out the TO and TE; the construction of the TUMS data base takes this into account."

Most of the questions about the TUMS data base validation procedures concerned the validation of Class II (clothing and individual equipment), Class VII (Major end items, non-square), Class VIII (medical supplies), and Class IX (repair parts) items. The validation of these classes of supply required that the weight and cube of these general cargo categories be estimated by the major subordinate commands. The validation procedure did not give sufficiently specific guidance to insure proper quality control in making these estimates. It left the specific procedure for making these estimates to the discretion of the major subordinate commanders. The TUMS Manager judged that most of the subordinate units made estimates based on good quality control standards, some units did not, and other estimates were so obviously in error that they were returned for further consideration.

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* Major J.P.B. Connell, USMC stated these facts on 22 January, 1976 in a meeting with this analyst.

One shortcoming of the validation procedure used in establishing and updating the TUMS data base is the lack of a quality control standard which could be applied in all units making estimates. Lacking that quality assurance standard, estimates made by the units are very dependent on the experience, conscientiousness, and time available to the personnel making the estimates. (see Section 4.8.3, page 28 for discussion).

The TUMS data base was not designed so that every item that a unit has is identified. Only the major end items, major fuel consuming items, weapons types, and class V supplies are specifically identified. For TUMS computer runs of individual units, these items are identified for each unit; for TUMS computer runs of forces, these items are identified for each force and not for the individual units making up the force. The cargo making up the general supply categories is identified only by weight and cube.

SECTION 3
THE MARINE AIR GROUND TASK FORCE LIFT REQUIREMENTS AND LOGISTICS PLANNING FACTORS MODEL (MAGTF) (1975-1985)

MAGTF, like TUMS, is a management information system developed to satisfy Marine Corps requirements for amphibious lift data.

The objectives of the model, as stated in the project directive which governed its development, are to:

a. Provide a computer-assisted model capable of producing embarkation and resupply lift requirements for Marine Corps Air Ground Task Forces, including the Navy elements which are normally part of landing forces.

b. Provide a means for producing a compendium of Marine Corps logistics planning forces.

c. Provide a means for calculating appropriate logistics planning data required by Fleet Marine Force Headquarters in a format suitable for JOPS use.

d. Compute embarkation and resupply lift requirements for selected Marine Air Ground Task Forces.

e. Provide documentation, including procedures for updating forces and logistics planning factors, for use by Marine Corps commands.

A description of the model's configuration and operation can be found in the user manuals for the system. This report will attempt to briefly describe the model in nontechnical terms.

The many reports the system is capable of providing are generated from a data base consisting of four separate data files. A detailed description of the files is presented in the Data Requirements Manual[2] for the system. The files are briefly described as follows:

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2. T. H. Allen et al, "Marine Air Ground Task Force Lift Requirements and Logistics Planning Factors Model (MAGTF) (1975-1985) Data Requirements Manual", Stanford Research Institute, December 1974.

(1) Unit File - A file containing the names of all units within the Fleet Marine Force and the notional Marine Amphibious Force (MAF), Marine Amphibious Bridgade (MAB), and Marine Amphibious Unit (MAU).

(2) System File - A file containing all the items of equipment including aircraft.

(3) Equipment File - A file containing detailed information on all major end items within the System File.

(4) Item File - A file containing information on all items in the System File.

Updating or expanding the data base from over 20 sources may be done by automated or manual means. All data in the data base come from planning documents; unlike TUMS, none of the data come from the individual units. This of course does not mean that the data base is without errors. The size of the data base and the lack of an easy way to check what data are in the data base for each unit lead to some questions as to the accuracy of the data items.

This study was not designed to provide an in-depth analysis of the accuracy of the data base. The final report of the validation study[3] of the MAGTF model conducted by the Development Center at the Marine Corps Development and Education Command (MCDEC) was a major source document for examining the accuracy of the data base. This report stated that a printout of the unit file amounted to 4400 standard computer printout pages. The unit file is only one of the four files making up the data base. A system with such a huge data base should have a means of validating the data base to insure that data have not been omitted or that incorrect data are not in the data base. If such a data base validation

3. "Validation of the Marine Air Ground Task Force Lift Requirements and Logistics Planning Factors Model", Marine Corps Development and Education Command, Final Report, March 1975.

procedure is not established, doubts about the accuracy of the data base will persist. The MCDEC study identified a number of errors in the data base (many were corrected during the course of the study and others have since been corrected). The study found greater accuracy in the Marine Corps furnished data than in the Navy furnished aviation logistics data. The maintenance of the system must take this into consideration and the Marine Corps must coordinate its data requirements with the Navy for the support of the MAGTF system.

The subject of data base accuracy was discussed with MCDEC personnel who participated in the MAGTF validation study, HQMC personnel who have been using the model, and SRI personnel who developed the model. In addition, the densities for Class V and general cargo were compared with densities from historic data obtained from the Military Sealift Command. None of these examinations into the accuracy of the data base revealed appreciable errors that had not been corrected. The density values of Class V and general cargo compare quite favorably with historic Class V densities. All the errors learned about in this examination could be corrected by simply entering the correct data in the data base. No errors were encountered which were due to incorrect computation algorithms in the model. The MCDEC validation study of MAGTF assessed the MAGTF data base to be capable of being updated to the 95% accuracy level for most classes of supplies. The MCDEC study judged the Navy furnished aviation logistics data to be no more than 60% accurate at the time of the study but capable of being update to an acceptable level of accuracy.

Errors will continue to be discovered in the data base with more use of the model. An error level of 40% in the aviation logistics data or any area of data is not acceptble. Some actions must be taken to minimize the occurrence of these errors as well as to provide for prompt changes to the data base to reflect changes in TO's, TE's, and other planning documents. The data base maintenance plan must consider inputs from all sources, both Navy and Marine Corps, and provide a means to verify the correctness of all data base items.

SECTION 4
TUMS AND MAGTF CAPABILITIES COMPARISON

4.1 GENERAL

Both MAGTF and TUMS were designed to provide a broad range of capabilities. The capabilities desired for the MAGTF model were set forth in the HQMC project directive. This directive stated that as a minimum the model must satisfy the following requirements:

a. Be capable of producing the following lift data:

(1) Personnel
- (a) Officer/enlisted
- (b) Marine Corps/Navy

(2) Individual weapons summary

(3) Total square (sq ft)

(4) Total cube (cu ft, MT)

(5) Total weight (ST, LT)

(6) Major end items summary by unit equipment (UE)
- (a) Weight (lb)
- (b) Square (sq ft)
- (c) Cube (cu ft)
- (d) Length (ft)
- (e) Height (ft)
- (f) Width (ft)
- (g) Fuel type and quantity (gals)

(7) Helicopter Summary by UE
- (a) Nested Storage (sq ft)

(b) Length (ft)

(c) Height (ft)

(d) Width (ft)

(e) Weight (lb)

8. Daily resupply requirements by classes of supply

9. Navy units normally accompanying the landing force

b. Be capable of:

(1) Dividing lift requirements into mutually exclusive groupings of Assault Echelon (AE) and Assault Follow-On Echelon (AFOE)

(2) Selectively eliminating from the lift requirement any equipment or major material item by virtue of its physical characteristics, e.g., all lifts over eighteen tons or all vehicles over ten feet in height

(3) Computing mobile loading capacities and utilizing those capacaties at the user's option

(4) Dividing lift requirements into unit load and landing force supply categories

(5) Varying the lift requirements for a given force by eliminating, substituting, increasing, or decreasing units, sub-elements of units, or equipment from the number or types allocated in the standard allowance without the necessity to change the files permanently

(6) Varying the days of supply computed for the various classes of supply

(7) Calculating other appropriate logistic planning data required by FMF Headquarters and producing such data in a format suitable for use in joint planning

c. Be capable of being updated as changes occur in the data base.

The capabilities of the TUMS model are stated in the TUMS user's manual. The manual states that TUMS will produce the following output:

a. Printed reports providing detailed description of type unit transportation requirements.

b. Card punched Type Unit Data (TUCHA) records (F1, F2, and F3 cards), defining notional type unit movement characteristics data in accordance with JCS Pub 6 Vl. II, Part 6, Chapter 3, (TYPREP).

c. Printed reports describing, in detail, transportation requirements for user selected type unit force aggregations.

The MAGTF validation study conducted by MCDEC states that "All required capabilities of the model set forth in the study outline plan have been demonstrated". The many successful runs of the TUMS model also demonstrate that it satisfies the capabilities for which it was designed.

This section of the report compares the major capabilities of the two models.

4.2 AE/AFOE LIFT COMPUTATION COMPARISON

A required capability of MAGTF, which was met, was to be able to divide lift requirements into AE and AFOE. This is an important capability since Marine forces are usually organized into echelons and lift expressions are developed for each echelon. This capability is also important to Marine Corps studies and OPLAN development and analysis. In additon to the capability to separate lift into assault and assault follow-on echelons, MAGTF can designate that some lift from the assault echelon is to be carried by the assault follow-on echelon and vice versa.

TUMS was not designed to be capable of separating lift into assault and assault follow-on echelons. This capability can be achieved with TUMS by separating the force into assault units and assault follow-on units external to use of the program. Each echelon would then be designated as a separate force (i.e., AE designated as force 01 and AFOE as force 02) and the force aggregation run. Force 01 would show the lift requirements for the AE and force 02 would show the lift requirements for the AFOE. Any AE forces or supplies carried with the AFOE would have to have been assigned to the AFOE for computational purposes.

The capability of the MAGTF model to allow the user to designate the lift of sub-elements of units from one echelon to be carried by the other echelon is the major distinction between the capabilities of the models in computing AE/AFOE lift requirements. For instance, if an engineer platoon from an engineer company in the AFOE is required in the AE, then the model user can construct the model input so that the lift for the platoon is included in the AE and not in the AFOE. This action does not require a data base modification for MAGTF but would require one for TUMS.

4.3 DAYS OF SUPPLY (DOS)

In MAGTF the DOS parameter is set by the model user. This gives the model user a very useful flexibility in that he can vary days of supplies to answer "what if" questions. For instance, a model user may need to examine the lift requirements for an AE force that could not be augmented by the AFOE for 5 days or 10 days or some other number of days. This type of examination can be made very easily with MAGTF. As another example, users may want to examine force structures or concept of operation in light of known shipping assets. If (after the force structure is selected and the lift requirements computed) it is determined that the force structure cannot be supported by the shipping assets, the MAGTF model user can vary DOS for all classes or for selected classes and determine whether an acceptable change in accompanying supplies can be made.

In the TUMS Model the number of days for which supplies are computed for a unit or force is fixed (i.e., the user does not control the number of days for which he wants supplies computed). The DOS is built into the structure of the model and was chosen on the basis of existing Marine Corps policy. The existing policy is to compute lift requirements based on 30 days of accompanying unit supplies and 30 days of non-unit related supplies so that the lift requirements to sustain the type units in combat operations during the interval D-Day to D+60 is computed.

TUMS was developed and is maintained as an in-house system. To give the TUMS model the same flexibility as MAGTF in computing DOS would constitute a major redesign of the model. Currently this type of model modification is not within the purview of FMFLANT. Such modification would require tasking the Marine Corps Centeral Design Programming Activity (CDPA) which services FMFLANT.

4.4 SELECTIVE ELIMINATION OF EQUIPMENT OR MAJOR MATERIAL ON THE BASIS OF PHYSICAL CHARACTERISTICS

MAGTF was designed to have the capability of selectively eliminating equipment or major supplies based only on the physical characteristics of the items. TUMS was not designed to have this capability. The Major Item Summary Report of the TUMS system identifies major end items by size categories (oversize, outsize, bulk, non-air-transportable). This report will allow the model user to eliminate major end items manually by subtracting their weight, cube, and square from the totals of the TUMS Lift Summary Reports. This manual procedure is not as efficient as the automated procedure of the MAGTF model but it accomplishes essentially the same objective.

4.5 MOBILE LOADED CARGO

Both MAGTF and TUMS have some capability for dealing with mobile loaded cargo. The capabilities of the two models and the ways in which they differ are discussed in the following paragraphs.

4.5.1 MAGTF

The mobile load capacities of vehicles, helicopters, and landing craft are considered in the MAGTF model. The use of these mobile load capacities is under the control of the model user. He can elect to compute lift requirements without mobile loading any cargo; with mobile loading only the capacities of vehicles; or with mobile loading the capacities of vehicles and helicopters; or vehicles and landing craft; or vehicles and both helicopters and landing craft. When mobile loading is selected, the cargo which can be mobile loaded is given priority as shown in Appendix B.

4.5.2 TUMS

Among the movement characteristic data of major items which appear in the Major Item Summary Report are the identification of major items which are normally mobile loaded in organic vehicles, and the cargo capacities of organic vehicles which could be used for mobile loading cargo. The normally mobile loaded cargo which appears in this report is

treated as mobile loaded cargo by the TUMS system. The square of these items is not included in the square summaries of any other reports produced by the model. TUMS does not mobile load any other cargo. It does compute the total capacity available which could be used for mobile loading and shows this total in the Lift Requirement Summary Report. The total does not include the cargo capacitites of aircraft or landing craft.

4.6 CLIMATIC CONDITIONS

MAGTF has the capability to compute the lift requirements for arctic, cold weather, or tropical areas. TUMS does not have this capability. It does not appear to be a major effort to provide TUMS with this capability but the benefits of so doing appear to be minor. If this capability is desired for TUMS, a good approach would be to determine percentage factors that could be applied to normal lift to compute the lift for the desired climatic areas.

4.7 WATER REQUIREMENTS

MAGTF has the capability of computing a unit's water requirement. The MAGTF data base contains each unit's organic water carrying capacity. On the basis of this value and the number of days for which supplies are computed, the model computes the supplementary capacity to satisfy the the unit's water requirements. TUMS does not compute a unit's water carrying capacity, nor does its data base contain the data needed to do so. If this capacity is required for the TUMS model, it could be provided with little difficulty since the water requirement is computed as a function of personnel. Organic water carrying capacity could be determined by field surveys of the units or by examination of the units' TE's.

4.8 COMPARISON OF OUTPUT PRODUCED BY THE TWO MODELS FOR THE SAME UNITS

This study has identified significant differences in the design goals of the two models, their data bases,and their capabilities. MAGTF computes lift requirements of a unit or task force based on the theoretical condition that a unit is at full personnel strength and has all of its authorized allowance and the supplies for the number of days

specified by the user. TUMS, on the other hand, computes lift requirements based on theoretical conditions for personnel strength, Class I supplies, major end items, weapons, and Class V supplies. The lift for other cargo is based on estimates made by the unit which has physical custody of the equipment or supplies.

The seven units shown in Table 1 were selected for the purpose of comparing the output of the two models. MAGTF identifies units by names and Table of Organization (TO) designations; TUMS identifies units by names and Unit Type Codes (UTC) used in the Joint Operations Planning System. These designations are shown in Table 1. Comparisons of lift computations for these seven units are shown in Tables 2, 4, and 5. The numbers shown in these tables are the actual numbers generated by the models and have not been rounded to indicate significant digits. The tables do not indicate which model gives the more accurate assessment because that could not be determined unless the true lift requirements for these seven units were known and they were not. Where large differences exist between the computations made by the two models, an attempt is made to give possible reasons for the differences.

TABLE 1 - SELECTED UNITS FOR COMPARISON

UNIT	TABLE OF ORGANIZATION (TO) -MAGTF-	UNIT TYPE CODE (UTC) -TUMS-
Rifle Company Infantry Battalion	M1013	OGVAA
105 mm Howitzer Battery	M1113	IHMAA
Truck Company Motor Transport Battalion	M1653	UJUAA
Helicopter Squadron (HMM)	M8937	3PNAA
Jet Squadron (A4)	M8855	3NSAB
Missile Battery	M8621	3LYAA
MACS	M8631	7LSAA

4.8.1 TUMS and MAGTF POL *Computations Comparison*

Table 2 shows the comparison of the POL requirements produced by the two models for these seven units. This table shows that the TUMS model differs from MAGTF by less than 10% for all units except the 105mm Battery and MACS units, which differ from MAGTF by 28% and 24%, respectively. The total POL requirements computed for the seven units by the two models are within 8% of each other.

An attempt was made to account for the difference in POL for the seven units. It was easy to identify the fuel consumers considered in the TUMS model and the rate of consumption used. This information is printed in the TUMS Class III summary report. The fuel consumers in the MAGTF system are not identified in any report. They were found by laboriously searching the System File.

The difference in POL requirements was attributed mainly to the fact that TUMS computes fuel requirements for major items like vehicles, aircraft, and large generators, but does not compute fuel requirements for fuel consumers that are not considered major items.* Fuel consumers in the non-major items category include small generators, space heaters, personnel POL requirements (insect control, etc.), stoves, etc. MAGTF computes a unit's POL requirements based on all requirements contained in the planning documents. It is therefore expected that the TUMS computation would be lower than that of MAGTF.

SRI** determined (during the development of the MAGTF model) that approximately 12% of a unit's fuel requirement is attributable to the non-major items. When this 12% factor is applied to the total POL requirements for the seven units as computed by TUMS, the TUMS total is 1,116,696 gallons. This total is within 4% of the MAGTF total.

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* TUMS defines major items as vehicles, including non-self deployable aircraft (NSDA) and other items of equipment which (due to dimensional characteristics) are loaded aboard ships and aircraft by application of the same techniques applied to vehicle cargo.

** This information was reported by Tom Allen, the SRI point of contact for the MAGTF system, in a meeting held at HQMC (Code LPC) on 31 March 1976.

TABLE 2 - TUMS AND MAGTF POL COMPARISON

	TUMS (GALLONS)				MAGTF (GALLONS)				
UNIT	DIESEL	MOGAS	JP	TOTAL	DIESEL	MOGAS	JP	TOTAL	TUMS/MAGTF
M1103	13560	4200	0	17760	17673	6851	0	24524	0.72
M8855	19920	14520	501120	535560	44903	13905	501907	560715	0.95
M1013	0	0	0	0	216	3031	0	3247	–
M1653	40620	1800	0	42420	41877	3923	0	45800	0.93
M8621	28350	2760	0	31110	29798	2190	0	31988	0.97
M8631	146670	5430	0	152100	182275	17275	0	199550	0.76
M8937	9720	12360	196020	218100	11645	6682	196959	215286	1.01
TOTALS	258840	41070	697140	997050	328387	53857	698866	1081110	0.92

The 12% factor does not bring the two POL computations into such close agreement when applied to individual units, but it does appear to be a good estimate of POL consumption for non-major items for a force of several units. This factor was applied to the total gallons of POL computed by TUMS for a Marine Amphibious Force (MAF) and the result was compared to the total POL computed for the same MAF by MAGTF. The organizational structure of this MAF (identifying the assault echelon, assault follow-on echelon, and fly-in echelon) is shown in Appendix C. Table 3 shows that the POL computed by TUMS for this MAF is 38,708,102 gallons and the total POL computed by MAGTF computed is 44,437,093 gallons. The TUMS figure is 87% of the MAGTF figure but when the 12% factor is applied to the TUMS figure it becomes 97.6% of the MAGTF figure. As before, the application of the 12% factor brings TUMS to within 4% of that of MAGTF.

Both MAGTF and TUMS compute POL requirements based on fuel consumption factors presented in the TAM. These factors were checked in the data bases of both models for many of the major fuel consumers. In all cases checked, both data bases contained the correct factors.

4.8.2 TUMS and MAGTF Square Cargo Computations Comparison

The square-loaded cargo requirements unit-for-unit compares favorably in most cases as shown in Table 4. The total square for the seven units as computed by TUMS differs from that computed by MAGTF by 7%. Most of the differences could be traced to differences in square-loaded cargo items of equipment in the data bases of the two models. In some cases, one data base had a more recent TE than the other. Table 3 shows that the square cargo computed by TUMS for the entire MAF also differs from the total square computed by MAGTF by 7%.

TABLE 3 - TUMS AND MAGTF LIFT COMPUTATIONS FOR A MAF

CARGO CATEGORY	AE			AFOE			FLY IN			MAF TOTALS[a]		
	TUMS	MAGTF	TUMS/MAGTF	TUMS	MAGTF	TUMS/MAGTF	TUMS	MAGTF	TUMS/MAGTF	TUMS	MAGTF	TUMS/MAGTF
PERSONNEL	32480	34157	1.00	7342	7941	0.92	5312	5040	1.05	46934	47138	1.00
SQ CARGO (sq ft)	830427	902586	0.92	508156	542687	0.93	52140	55275	0.94	1390723	1500548	0.93
SQ CARGO (ST)	34399.8	36641.8	0.94	19898.5	19971.6	1.00	1894.1	1597.4	1.18	56192.4	58210.8	0.96
GENERAL CARGO (cu ft)	1325890	2276470	0.58	4567837	2121665	2.15	578679	351958	1.64	6472406	4750093	1.36
GENERAL CARGO (ST)	9938.0	17706.2	0.56	30110.0	24644.4	1.22	1722.9	6440	0.27	41770.9	48791.2	0.86
CLASS V(W) (cu ft)	435879	334165	1.30	678524	809717	0.84	549	1964	0.28	1114952	1145846	0.97
CLASS V(W) (ST)	12620	19350.4	1.35	19635	23139.4	0.85	18.5	37.4	0.49	32273.5	35527.2	0.91
CLASS V(A) (cu ft)	80167	48681	1.64	1398487	1098267	1.27	385995	81626	4.73	1864649	1228574	1.52
CLASS V(A) (ST)	1864.2	1259.7	1.48	32336.4	58449.1	0.55	8914.6	4620.8	1.93	43115.2	64329.8	0.67
CLASS III Pkg (cu ft)	95256	118142	0.81	130986	252575	0.52	–	–	–	227242	370717	0.61
CLASS III Pkg (ST)	1621.9	2126.7	0.76	2339.4	5309.4	0.44	–	–	–	3961.3	7436.1	0.53
CLASS III BULK (Mogas) (gal)	119076	178797	0.66	2977706	4638578	0.64	–	–	–	3096782	4817375	0.64
CLASS III BULK (Diesel) (gal)	435231	500247	0.87	11719167	16551110	0.71	–	–	–	12154398	17051357	0.71
CLASS III BULK (JP) (gal)	627688	619895	1.01	22829252	21948466	1.04	–	–	–	23456940	22568361	1.04

Note a – The total bulk POL for TUMS and MAGTF is 38708120 gallons and 44437092 gallons respectively. The TUMS total is 87 percent of the MAGTF total

4.8.3 TUMS and MAGTF Cube Computations Comparison

Table 4 also shows the cube lift for the seven selected units computed by MAGTF and TUMS. For the individual units, TUMS' cube computation varied from as much as two and one-half times MAGTF to 24% of MAGTF's cube computation. When all seven units were taken collectively, TUMS cube computation was 72.2% of MAGTF's.

Table 3 also shows the cube computations for a MAF. The difference here between the computations of the two models is as widely spread as above for the seven units. TUMS' cube computation was 58% of MAGTF in the AE, 215% in the AFOE, 164% in the Fly-In, and 136% for the entire MAF.

Several factors were identified as contributing to the large differences in the cube computations of the two models. First, there is a basic difference in the way that cube computations are made for the individual units. MAGTF computes the cube of all general cargo which accompanies a unit plus all general cargo which supports the unit and prints this sum as the cube for the unit. TUMS, since it relies on estimates of the cube of the general cargo, includes in a unit's cube estimate the cube of all general cargo which is in its physical possession. This means that the weight and cube of third and fourth echelon repair parts are included in the weight and cube for the unit in which the parts will be needed in MAGTF and in the weight and cube of the unit which physically carries the items in TUMS. For this reason Table 4 does not give a valid comparison of the cube computations of the two models. Table 3 gives a more valid comparison in the MAF total columns because these columns give the totals of the general cargo in the MAF. The values in these columns are independent of which lower echelon unit has possession of the cargo or what unit will use the cargo. Even in this case TUMS gives a 36% greater value than MAGTF; this indicates that the cause of that difference should be further investigated.

A second factor contributing to the differences in the two cube computations was the method used to determine the cube factors which are in the data bases. MAGTF uses the same procedures for every unit and therefore there is consistency in cube computations for every unit. Essentially, MAGTF determines the general cargo that has to be lifted for each unit. This information is obtained from the planning

documents. Then MAGTF determines how the items are shipped (i.e., box, crate, container, pallets, etc.) and determines what percentage of the box, for instance, each item occupies; that volume is the volume of the item contained in the data base. For instance, if helmet liners are nested and shipped 200 per crate, then the cube assigned to one helmet liner is 1/200 of the cube of the crate.

TUMS determines the cubes of its general cargo by estimates made by the units which have physical possession of the cargo. Because these estimates were made by many different individuals under different circumstances, and because no standards were established for making the estimates, some of these estimates may be significantly in error. An examination of one unit revealed that the total cube assigned to that unit was much lower than the cube of the unit equipment items in the equipment allowance file for that unit. There is no way to trace the specific items on which the cube in TUMS is based.

Another indication that the TUMS' cube is significantly in error comes from the comparison of the density of the TUMS cube computation with the average density of general cargo based on experience from the Military Sealift Command (MSC).[4] The density of general cargo for the MAF as computed by TUMS is 12.91 lb/cu ft. The average density for this cargo based on historic data as reported by MSC is 21.53 lb/cu ft. The density of the general cargo for the MAF as computed by MAGTF is 20.54 lb/cu ft, which is close to the MSC value.

4.8.4 TUMS and MAGTF Class I Computations Comparison

Computations of Class I supplies for the seven units compared quite favorably as shown in Table 5. Both models compute Class I values in essentially the same way by basing the computation on the number of personnel in the unit or force. The major differences in the Class I computations were differences in the types of meals provided and in the number of days for each type. Days for which the units would subsist on Meal Combat Individual (MCI) and "A" or "B" rations were not the same for the two models.

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4. Integrated Sealift Study, Volume II Appendix K, OCNO/DCNO (Logistics) November 1970.

TABLE 4 - TUMS AND MAGTF SQUARE AND CUBE COMPARISON

	SQUARE FEET			CUBIC FEET		
UNITS	TUMS CLASS VII	MAGTF CLASS VII	TUMS/MAGTF	TUMS*	MAGTF*	TUMS/MAGTF
M1103	4365	4842	0.90	21975	22395	0.98
M8855	7252	7680	0.94	84598	161540	0.52
M1013	0	0	–	2239	7270	0.30
M1653	9741	8608	0.88	2487	3531	0.70
M8621	5664	6964	0.81	19429	14336	1.36
M8631	19654	14592	1.34	64434	25501	2.52
M8937	16227	15842	1.02	12598	52977	0.24
TOTALS	62903	58528	1.07	207760	287550	0.72

*The cube of the Bulk POL is not included and neither is the cube of the square-loaded cargo.

TABLE 5 - TUMS AND MAGTF CLASS I COMPUTATIONS COMPARISON

	PERSONNEL		TUMS		MAGTF		DENSITY[c]	
UNIT (TO)	TUMS	MAGTF	CUBE[a]	WEIGHT[b]	CUBE	WEIGHT	TUMS	MAGTF
M1103	136	126	737	11.7	706	11.56	31.75	32.75
M8855	211	227	975	15.3	1303	21.32	31.38	32.72
M1013	207	207	1101	17.5	1202	19.66	31.78	32.71
M8621	120	120	573	9.0	697	11.4	31.41	32.71
M1653	79	79	446	7.0	443	7.25	31.39	32.71
M8631	271	271	1239	19.5	1573	25.74	31.48	32.73
M8973	248	248	1137	17.9	1425	23.31	31.49	32.72
TOTALS	1272	1278	6208	97.9	7349	120.24	31.54	32.72

NOTES: [a]All cube measures are in cubic feet.
[b]All weight measures are in short tons (ST).
[c]All density measures are in pounds/cubic foot.

MAGTF provides the user with the flexibility to select the type of rations to be provided and the number of days for each type. TUMS does not provide this flexibility. In TUMS, ration types and the days of each type are fixed in the model structure in accordance with existing policy on determining rations requirement.

4.8.5 TUMS and MAGTF Class V Computations Comparison

Computation of Class V supplies by the two models was considered for the MAF runs only. A unit-by-unit comparison was not considered valid because MAGTF includes (in a unit's Class V supplies) all Class V that the unit carries as its organizational load plus what is carried for that unit by support units in the Landing Force Supplies. TUMS does not segregate lift into Organization Load and Landing Force Supplies. It computes Class V supplies like other general cargo in that a unit's Class V printout would not show the Class V supplies which are carried for that unit by supporting units.

The Class V(W)* computations compared favorably for the MAF (Table 3) in both cube and weight. TUMS' Class V(W) cube computation was 97% of MAGTF and its weight computation was 91% of MAGTF.

The comparison was not so favorable for the Class V(A). In cube, the TUMS figure was more than 150% that of MAGTF, but in the weight of that cube the TUMS figure was less than 70% that of MAGTF. The TUMS density factor is 46.24 lb/cu ft, whereas the MAGTF density factor is 104.72 lb/cu ft. The average density factor[4] for this category of Class V supplies is 56.56 lb/cu ft. Both FMFLANT and MCDEC indicate that the data of their respective models were not as accurate for Class V(A) as for Class V(W). One reason given in the case of MAGTF was that the Marine Corps had not established procedures to insure that complete and up-to-date Navy source data were being provided to the MAGTF data base.

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* In both MAGTF and TUMS, the subclass (W) indicates equipment and supplies rates by Marines from Marine Corps sources; the subclass "A" indicates equipment and supplies rated by Marines from Navy sources; and the subclass "Z" indicates equipment or supplies rated by Navy units from any source.

SECTION 5
LIMITATIONS OF THE TUMS AND MAGTF MODELS

5.1 GENERAL

In assessing the limitations of the MAGTF and TUMS models, it is important to realize that the models were developed under different sets of circumstances. They were not designed to have the same capabilities nor should they be expected to. MAGTF evolved from a HQMC project directive and had the benefit of a MCDEC study advisory group during its development. TUMS evolved from initiatives from the FMF commanders to develop expedient procedures for the management of JOPS related information.

The capabilities of both models have now been addressed. MCDEC, in its validation study of MAGTF, stated that "All required capabilities of the model set forth in the study outline plan have been demonstated". No specific validation study outside of FMFLANT was done for TUMS, but HQMC attested to its acceptance of TUMS as valid by its use of the TUMS output in satisfying HQMC's requirements to the JCS for lift data for input to JCS TUCHA file.

This section of the report will identify limitations of each model with respect to the other and limitations of the models with respect to the Marine Corps requirements for amphibious lift data.

5.2 COMPUTER RESOURCES AND MAINTENANCE REQUIREMENTS

5.2.1 MAGTF

A major limitation of MAGTF is its requirement for computer resources. The model was designed to be very flexible and very comprehensive and so requires a large computer system and a large amount of computer time for a large force such as a MAB or a MAF. In January 1975, it took 63 wall clock hours to process a MAF and generate the JOPS Cards. After considerable modification to reduce the model's running time without reducing its capability, the model presently requires 20 wall clock hours to process the same MAF. Both of these processing times are for the IBM 360/65 computer.

No attempt has been made to install MAGTF on a computer system of the magnitude of the IBM 360/30 which is resident in HQ FMFLANT. MAGTF is currently operational on the IBM 360/65 resident in HQMC. If MAGTF, in its reduced version, could run on the IBM 360/30, the running time would be at least five times longer than on the machine at HQMC. Even if the running time on the IBM 360/30 were only twice the running time on the model 65, MAGTF would probably be too unresponsive to the needs of the FMFLANT to justify installing it at HQ FMFLANT. In addition, runs of MAGTF would probably have to be scheduled far in advance and HQ FMFLANT would not be able to respond in the short time possible with TUMS. HQ FMFLANT can presently respond to a tasking in less than two hours, in many cases even when a run of the model has to be made.

The computer running time of MAGTF has been reduced significantly since the model has been on line and further modifications, which will probably result in further reduction of running time, have been proposed by SRI. In light of the fact that MAGTF's running time may be reduced significantly, it is not recommended that MAGTF be considered for installation at FMFLANT in its present configuration.

The maintenance of the MAGTF data base is an extensive undertaking and requires supervision by someone with an in-depth understanding of the technical details of the model as well as of the update programs. The update programs extract data from Navy and Marine Corps sources and process it for input to the MAGTF data base. These update programs must be kept current with the sources of input data. The validity of the MAGTF model can be assured only through planned and continuous maintenance of the data base, as opposed to the periodic update of the TUMS data base.

5.2.2 TUMS

Computer resources and running time required for the TUMS model are not nearly as critical as they are for the MAGTF model. In fairness to MAGTF with respect to computer running time, MAGTF would be as fast as TUMS if it treated large masses of data as a single data item as TUMS does. MAGTF was designed so that in theory the data base could be updated as often as changes occurred in the planning documents on which the data

base is founded. The TUMS data base was designed to be adjusted for accuracy annually and therefore data items can be handled collectively.

The operation and maintenance of the model are within the capabilities of FMFLANT as long as major structural changes to the model are not required and FMFLANT maintains the level of computer programming capability that it had when TUMS was developed.

5.3 FLEXIBILITY

5.3.1 MAGTF

MAGTF's greatest asset may be its flexibility. The model was designed not only to support requirements based on existing policies but to support Marine Corps studies in which new policies may be proposed and analyzed. MAGTF's flexibility comes from the fact that the system has a large data base from which the model user can extract data under many options which he controls.

The use of this flexibilty is currently limited by inadequate model documentation, although several documents on the model were published by SRI. All the documents are addressed primarily to technical personnel who would be physically involved in data preparation to run the model or in some phase of maintaining the data base. Much of the flexibility of the model is lost because potential users at the management level are concerned with choosing a tool to solve a lift requirement problem and do not need to know such technical details as how many files make up the data base or the difference between header records and trailer records. These managers need a document from which they can learn what family of problems the model can solve so that they can decide on the applicability of the model to their particular problem.

HQMC recognized that the usual report which completes a study was not done. An internal HQMC Memorandum[5], stated that:

5. HQMC Memorandum RDS/LPC-ast-1 dated 14 Nov 75, from Deputy Chief of Staff for Research, Development and Studies to the Chief of Staff re: "Marine Corps Study Marine Air Ground Task Force Lift Requirements and Logistics Planning Factors Model, (1975-1985)".

"Because of the unusual nature of this study project a conventional study report has not been produced. Rather, an operating computer model has been developed and provided to the Marine Corps. A standard set of documentation required to support the model has been provided which included manuals for data requirements; command (management); computer operations; program maintenance, and, a Test and Implementation Plan."

The memorandum goes on to say that the MCDEC validation study of MAGTF is "appropriately" the record of achievement for this study and is considered the "study report".

The MCDEC study was written as a validation of the MAGTF model. The report does not take the place of an executive summary or report which will tell a potential user of the model what he needs to know to determine whether the model can solve his particular problem.

The publication of a technical executive summary report on the MAGTF model would contribute greatly to a better understanding within the Marine Corps of the capabilities of the model. Such a publication would also help to make the capabilities and flexibilities of this model known to the R&D communities where this model has many potential uses in Marine Corps studies.

A computer model like the MAGTF model is subject to becoming outdated as policy or concepts of operations change. Some of these changes cannot be handled by changes to data elements in the data base but require changes in the structure of the model. The model should be sufficiently well documented so that its users can recognize when changes of this type are indicated.

5.3.2 TUMS

TUMS greatest limitation is its lack of flexibility when its capabilities are compared to the capabilities of the MAGTF model. TUMS does not seem as inflexible when its capabilities are compared to the operational requirements which it was developed to satisfy. The capability to adjust to changes in policy was not built into the model. For instance, policy may change so that units are to arrive in the objective area with sufficient POL to be sustained in combat operations during the

interval D-Day to D+70 instead of D-Day to D+60. The POL lift requirements for the new interval could not be computed by TUMS without modification to the model.

The TUMS User's Manual[1] serves both as an executive summary and as a users manual. Since the TUMS model is not as complex as MAGTF, this one document serves both functions quite adequately as long as HQ FMFLANT is the primary user of the system. If TUMS is to be considered the primary model to support Marine Corps studies and requirements in HQMC in other than the areas for which it has already been used, additional documentation will be needed.

Table 6 provides a comparative summary of major characteristics of the two models.

TABLE 6 - COMPARATIVE SUMMARY - MAGTF AND TUMS

ITEM	MAGTF	TUMS
Minimum Computer Requirements	IBM 360/65	IBM 360/30
Computer Time: MAF Lift Requirements	20 Hours	1 Hour
Data Base Quality	Accuracy level: high (about 95%) for items rated by Marine Corps documents; much lower (about 60%) for items rated by Navy documents	Accuracy level: high (about 95%) for major end items, Class I, and Class V supplies; other items, poor (weight and cube based on field estimates)
Flexibility	Highly flexible; parameters, e.g., days of supply, type of rations, mobile loading equipment options, elimination of equipment based on dimensions, division of lift into AE and AFOE groupings, computation of water requirements and water carrying capacity needed in addition to organic capacity, climatic conditions, are under the control of the model user.	Highly inflexible, e.g., lift is computed based on fixed conditions in the model structure in accordance with existing policy; model is not applicable for examining lift under alternative policies.
Maintainability	Major effort required to maintain current, accurate data in the base; dedicated group with members knowledgeable in both model structure and data base required on a continuing basis.	Once-a-year data base update required involving HQ FMFLANT and its major subordinate commands. The present data base maintenance procedure is insufficient for insuring and maintaining an accurate data base.
Major modifications needed to satisfy Marine Corps requirements	1. Running time must be reduced. 2. Increase compatibility with the operational needs of the FMF's. 3. Data base auditing procedures to insure accuracy must be *developed*.	1. Computation algorithms must be changed so that lift can be computed for conditions other than those provided for in existing Marine Corps policy. 2. Data base must be redesigned so that it can be updated to reflect changes to items without having to conduct a field survey.
Documentation	Not adequate. Present documentation addresses technical aspects of the model, i.e., file structure, data base maintenance etc.; non-technical executive summary needed in addition.	Adequate for FMFLANT stated needs. If TUMS is to become a major tool to support Marine Corps studies or HQMC planning efforts, additional documentation covering an executive summary and model maintenance is needed.
Estimated Cost to make recommended modifications	Model modifications: $160K. Data base maintenance 100K/yr.	Model modification: Not estimated because the modifications needed in order for the model to satisfy the Marine Corps requirements for an automated lift computation capability are so extensive that it constitutes the development of a new model.

SECTION 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The study concluded that:

(a) Neither MAGTF nor TUMS in its present configuration will satisfy the Marine Corps' requirement for a computerized amphibious lift computation capability as stipulated in basic directives quoted in Section 4. MAGTF has much greater potential for satisfying this capability than the TUMS model. TUMS major shortcoming lies its lack of flexibility. MAGTF's major shortcoming is its excessive computer time and computer hardware requirements.

(b) A major factor contributing to excessive computer time of MAGTF is that, each time the model is run for an individual unit or force, the lift for each individual unit must be re-computed. If the model were modified so that it could store the lift for a unit until a data base change occurs or the lift is required to be re-computed under different user chosen conditions, the model's run time could probably be reduced considerably for subsequent runs as long as the user employs the same conditions (i.e., same distribution of lift between organization load and landing force supplies,etc.). When conditions are changed, the stored lift cannot be used and a new lift for each unit must be computed. Another approach, which may be more productive in reducing runtime, would be to analyze the techniques used by the system in searching and retrieving data from the files to determine whether these techniques can be used more efficiently.

(c) MAGTF and TUMS are more accurately described as complementary models than as competing models. In their present configuration neither model can replace the other without a loss of either

capability or responsiveness. The models compete in satisfying the requirements of the JOPS ADP system even though their results will differ slightly. They do not compete in satisfying the requirements of periodically updating the Marine Corps' expression of the amphibious lift requirements for a MAF. MAGTF can clearly perform this function more satisfactorily than TUMS.

(d) The capabilities of TUMS can be duplicated closely enough by MAGTF for TUMS to be described as a subsystem of MAGTF. MAGTF cannot be substituted for TUMS on the present FMFLANT equipment because of the computer capacity required for MAGTF.

(e) The data bases of both models contain errors. Most of the errors in TUMS were attributed to errors made in estimates of the weight and cube of general cargo. The MCDEC validation study of MAGTF found more errors in the aviation logistics data than in other areas of the data base. The error levels of both data bases were significant. However, the error level of the data bases for both models could be reduced by instituting better quality control procedures for determining data base entries.

(f) MAGTF is not documented sufficiently well for potential users to fully appreciate the capabilities and flexibilities of the model. It needs an executive summary report.

(g) TUMS' data base can be made substantially more accurate by establishing better quality control procedures for determining the weight and cube of general cargo. This would require that the weight and cube of many items be physically measured.

(h) MAGTF can be properly maintained only if HQMC formally establishes procedures whereby all sources will provide input data on a regular basis and in the format required.

(i) MAGTF must be maintained by a dedicated group. The accuracy of which the model is capable cannot be achieved otherwise.

6.2 RECOMMENDATIONS

This study recommends that MAGTF be modified to:

(a) reduce its computer time,

(b) make it compatible with the FMFs requirements and

(c) provide for auditing of data elements of the data base for possible errors,

and that it then be adopted by the Marine Corps to satisfy its requirements for an automated amphibious lift computation capability.

In addition, it is recommended that additional documentation be provided describing the uses of the model in nontechnical terms so that potential users of the model would have a good source from which to determine the applicability of the model to problems of their concern. The study also recommends that a special group be assigned the data base maintenance function.

The level of funding required to accomplish the recommended modifications is estimated to be $160,000. The annual maintenance cost is estimated to be $100,000. Both of these estimates are based on the funding figures presented in a technical proposal* developed by SRI for improvement and maintenance of the MAGTF model.

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* " MAGTF Improvement And Data Base Maintenance", Stanford Research Institute, Proposal EGU 75-238 (8 October, 1975).

Three other alternative recommendations were considered in arriving at these recommendations. The first alternative was that TUMS, or a modified version of it, be adopted by the Marine Corps to satisfy its requirements for amphibious lift computations. This recommendation was rejected because of the level of effort that wuld be needed to upgrade TUMS to satisfy the broad requirements of the Marine Corps for an automated lift capability as expressed in the project directive that initiated the MAGTF study. These requirements were stated in Section 4 of this report. TUMS did not satisfy many of these requirements and is not capable of being upgraded to satisfy them without a major modification effort. The level of modification was judged to be more appropriately referred as to as a new model rather than a modification.

The second alternative considered was that some combination of MAGTF and TUMS be adopted by the Marine Corps to satisfy its requirements for amphibious lift computations. This alternative was rejected because the operation of two systems, which overlap in some areas but have such different levels of accuracy in the areas of overlap, is not a good compromise when one of the systems, after relatively minor modifications can serve the purposes of both with greater accuracy than either system is now capable of.

The third alternative considered was that a new system be developed to satisfy the Marine Corps requirements for amphibious lift computations. This alternative was rejected because no lift computation requirements have been identified other than those presently satisfied by the use of either MAGTF or TUMS. The modification of MAGTF would require much less effort than the design and development of an entirely new system.

APPENDIX A

DESCRIPTION OF REPORTS PRODUCED BY THE TUMS MODEL

1. Units or Force Major Items Summary. This report provides a list of Unit or Force Major Items (vehicles or other equipment requiring square stow) in System Identification (SYSID) number sequence. The report lists description, dimensions, size category, cargo carrying capacity, and Unit or Force density for each item in Unit Equipment and Accompanying Unit Supplies. (Non-Unit Related Supply Density is displayed on Force reports only.) In addition, those items which are normally mobile loaded in other organic vehicles are identified.

2. Unit or Force Major Item Summary Recapitulation. This report summarizes size category totals for vehicles by Unit Equipment, Accompanying Unit Supplies, and Non-Unit Related Supplies (Force reports only) and provides Unit or Force totals. The square foot totals do not reflect the square of any equipment which is normally mobile loaded in organic unit transportation.

3. Unit or Force Class III Summary. This report provides a list of Unit or Force fuel consumers in SYSID sequence. The report lists density, description, type of primary and secondary fuel required, and daily and 30-day fuel consumption rates for the density of items displayed.

4. Units or Force Class III Summary Recapitulation. This report summarizes the total 30-day bulk fuel requirements by fuel type and total gallons and displays the associated packaged POL requirements for 30 days.

5. Unit or Force Class V Summary, Weapons Density. This report lists the density and types of weapons organic to the Unit or Force.

6. Unit or Force Class V Summary, Class V(W). This report provides a list of ground ammunition requirements in 30-day increments. (Subsequent 30-day increments are output in Force Reports only.) The number of rounds,

number of packages, and cube and short tons for each type of ammunition are displayed. Unit or Force total Class V(W) cube and weight (short tons) are also displayed.

7. <u>Unit or Force Class V Summary, Class V(A).</u> This report provides a list of aviation ammunition requirements and provides first 30-day and subsequent 30-day (Force Reports Only) quantitites, number of standard packages, and cube and weight for each type of ammunition. Unit or Force total Class V(A) cube and weight (short tons) are also displayed.

8. <u>Unit or Force Lift Requirement Summary.</u> This report reflects personnel strengths, provides square feet, cubic feet, and weight (short tons) data for each supply class, and gives aggregate Unit or Force movement characteristics.

9. <u>Unit or Force Lift Requirements, Recapitulation.</u> This report summarizes the lift requirements displayed in the Lift Requirements Report by size category.

10. <u>TUCHA Card.</u> TUCHA Cards are output only when requested by the System Mnager.

> 1. <u>TUCHA Card Type F1 Card, Movement Characteristics Card.</u> This card is a Type Unit Summary Card which provides unit type codes, and identifies the number of personnel requiring transportation and the number of F2 (Cargo Detail) cards associated with this type unit.
>
> 2. <u>TUCHA Card Type F2, Cargo Detail Card.</u> This card is a summary record for each cargo category within type unit movement characteristics. The card summarizes by unit type codes and cargo category the total square feet (if applicable), short tons, measurement tons (or hundreds of barrels for bulk POL), and summarizes the number of any F2 (Cargo Category Detail) cards associated with this cargo category.

3 <u>TUCHA Card Type F3, Cargo Category Detail Card</u>. Each card identifies a unique type of equipment (vehicles, aircraft, or floating craft) within that cargo category. Each type of equipment is identified by a unique card number to distinguish it from other F3 cards associated with the same F2 card. This card provides a description and the dimensions of the equipment, the number of pieces of this type of equipment, and the measurement tons of all items being described in this card. (40 cubic feet equal one measurement ton.)

11. <u>TUCHA Card Listing</u>. A sequential listing of all TUCHA cards.

12. <u>DEPREP Cards.</u> DEPREP (Deployment Reporting) Cards provide a means for conveying data among commands and agencies involved in applications of the JOPS. These cards are provided at the option of the System Manager.

13. <u>DEPREP Listing</u>. A sequential listing of DEPREP output.

APPENDIX B

PRIORITY FOR MOBILE LOADING CARGO IN THE MAGTF SYSTEM

Mobile loading priority:

(1) Class VII NML
(2) Class VW
(3) Class VA
(4) Class II (5-gal cans, water)
(5) Class II (5-gal cans, diesel)
(6) Class II (5-gal cans, MOGAS)
(7) Class I
(8) Class VIII
(9) Other Class VII (non-square)
(10) Other Class II
(11) Class III (55-gal drums, diesel)
(12) Class III (55-gal drums, MOGAS)
(13) Class III (55-gal drums, JP)
(14) Class IIIW lube (55-gal drums)
(15) Class IIIA lube (55-gal drums)
(16) Class IV
(17) Class IIIW (MARCORPS) (55-gal drums)
(18) Class IIIW (MARCORPS) (packages)
(19) Class IXA
(20) Class IXW
(21) Class III (5-gal cans, kerosene)
(22) Class III (55-gal drums, kerosene)
(23) Class VI
(24) Class X

APPENDIX C

MARINE AMPHIBIOUS FORCE (MAF) UNITS

MAF ASSAULT ECHELON (AE)

MULTIPLE	UNIT	
	ADVANCE FORCE ELEMENTS	
1	FORCE RECON CO.	
	ASSAULT ELEMENTS (SCHEDULED AND ON-CALL SERIALS)	
3	REGIMENTAL LANDING TEAM (RLT)	
		SUB-UNIT MULTIPLE
	HQS CO, INF REGT	(1)
	INF BNs	(3) less Reserve BN
	RIFLE CO (4)	
	H&S CO (1)	
	105mm HOW BTRY	(3)
	155mm HOW BTRY (TOWED)	(1)
	HQS BTRY, ARTY BN	(1)
	MEDIUM TANK CO	(1)
	RECON CO, RECON BN	(1)
	TWO PLT	(1)
	ENGR CO. ENGR BN	(1)
	AMTRAC CO (LVTP-7)	(1)
	SHORE PARTY CO	(1)
2	MARINE AIRCRAFT GROUP	(MAG) (-) (VH)
	HMH (21 CH53D)	(1/2)
	HMM (18 CH46D)	(2/3)
	HML (21 UHIN)	(1/1)
	HMA (24 AHIJ)	(0/1)
	VMO (18 OVIOA)	(0/1)
	VTOL SQS (20 AV8As)	(0/1)

MULTIPLE	UNIT	SUB-UNIT MULTIPLE
	NAVAL BEACH GROUP (NBG) (NAVY)	
	ASSAULT CRAFT UNIT	
	BEACH MASTERS	
	ASSAULT CONSTSRUCTIONS BNs	
1	BATTALION LANDING TEAM (BLT), (MAF RESERVE)	
	INF BN	(1)
	RIFLE CO (4)	
	H&S CO (1)	
	MEDIUM TANK CO	(1)
	ENGR PLT	(1)
	SHORE PARTY PLT	(1)
	AMTRAC CO	(1)
	RECON PLT	(1)
	NON-SCHEDULED UNITS	
	MAF HQS ELEMENTS	
	HQS MAF, H&S CO. MAF	(1)
	H&S CO, MAF	(1)
	CIV AFFAIRS GP	(1)
	CI TEAMS	(2)
	SSC TEAMS	(2)
	RADIO BN	(1)
	ALPHA CO (1)	
	BRAVO CO (1)	
	H&S CO (1)	
	COMM BN	(1)
	COMM SUPPORT CO (1)	
	LONG LINES CO (1)	
	COMM CO (1)	
	HQ CO (1)	

MULTIPLE	UNIT	SUB-UNIT MULTIPLE
	DIV HQS ELEMENTS	
	DIV HQS, HQS CO, HQBN	(1)
	HQS CO, HQS BN	(1)
	COMM CO, HQS BN	(1)
	MP CO, HQS BN	(1)
	SERV CO HQS BN	(1)
	FIELD ARTY GROUP (FAG)	(1)
	HQS BTRY (FAG)	(1)
	8" HOW BTY	(1)
	175 GUN BTRY	(2)
	SEARCHLIGHT BTRY	(1)
	155mm HOW BTRY (SP)	(2)
1	SERVICE BN (-)	
	SUP CO (-), SERV BN	(1)
	MAINT CO, SERV BN	(1)
	TRUCK CO, SERV BN	(1)
	H&S CO, (-) SERV BN	(1)
1	MEDICAL BN	
	C&C CO, MED BN	(4)
	H&S CO, MED BN	(1)
1	HQS BTRY, ARTY REGT	
1	ENGR SPT CO, ENGR BN	
1	H&S CO, ENGR BN	
1	MOTOR TRANSPORT BN	
	TRUCK CO	(3)
	H&S CO	(1)

MULTIPLE	UNIT	SUB-UNIT MULTIPLE
1	H&S CO, TANK BN	
1	MP BN	
	MP CO	(3)
	H&S CO	(1)
1	H&S CO, SP BN	
1	H&S CO, AMTRAC BN	
1	MARINE AIRCRAFT WING HQS ELEMENTS (AE)	
	MAW HQS, MWHS (-) (AE)	(1)
	MWHS (-) (AE)	(1)
1	MACG	
	MWCS	(1)
	H&S MAGG	(1)
	FAAD BTRY	(1)
	MACS/MTDS	(1)
	MASS MACG	(1)
1	MISSLE BRTY, LAAM BN	
2	DET MAG (VH)	
	H&MS (SINGLE SITE)	(1)
	MABS (SINGLE SITE)	(1)
	MATCU	(1)
1	FORCE SERVICE SUPPORT COMMAND HQS ELEMENTS (FS SC) (AE)	
	FSSG HQS (-) (AE)	(1)

MULTIPLE	UNIT	SUB UNIT MULTIPLE
1	LAAM BN (-)	
	H&S BTRY	(1)
	MISSILE BTRY	(2)
1	MWSG (1)	
	H&MS	(1)
	WERS	(1)
3	MATCU	
1	DET FORCE LOGISTIC COMMAND HQS	
1	SEPBULK FUEL CO	
1	BRIDE CO	
4	DENTAL CO	
1	MP CO	
1	HOSPITAL CO	
1	SEP SURGICAL CO	
1	DET SERV BN	
	DET H&S CO	(1)
	DET SUP CO	(1)
1	MT BN	
	TRUCK CO	(3)
	TRANSPORT CO	(1)
	H&S CO	(1)
1	DET ENGR BN	
	ENGR CO	(2)
	DET SVC CO	(1)
	DET HQ CO	(1)
1	FORCE SERVICE REGIMENT (-)	
	GS SUPMAINT CO	(1)
	MT MAINT CO	(1)
	H&S CO (-), MAINT BN	(1)
	SUP CO (-), SUP BN	(1)

MULTIPLE	UNIT	SUB UNIT MULTIPLE
1	DET FORCE SERVICE REGIMENT (FSR)	
	ORD MAINT CO	(1)
	DET MT MAINT CO	(1)
	ENGR MAINT CO	(1)
	DET H&S CO MAINT BN	(1)
	ELEC MAINT CO	(1)
	DET SUPPLY CO, SUP BN	(1)
	DET RATION CO	(1)
	BULK FUEL CO	(1)
	DET AMMO CO	(1)
	DET SUPPORT CO	(1)
1	ENGR BN (-) (CSSE)	
	ENGR CO, ENGR BN	(2)
	SERV CO (-), ENGR BN	(1)
	HQ CO (-), ENGR BN	(1)

ASSAULT FOLLOW ON ECHELON

		SUB-UNIT MULTIPLE
1	DET MAF HQS ELEMENT	
	CI TEAMS	(2)
	TOPO PLT	(1)
1	DET MARINE AIRCRAFT WING HQS (AFOE)	
	DET MWHS (AFOE)	
	MABS, MAG VA/VF/VA (AW)	

MULTIPLE	UNIT	SUB UNIT MULTIPLE
	RAT CO (-), SUP BN	(1)
	AMMO CO (-), SUP BN	(1)
	H&S CO, SUP BN	(1)
	LNGSHOR CO, H&S BN	(1)
	SPT CO (-), H&S BN	(1)
	TRUCK CO, H&S BN	(1)
	COMM CO, H&S BN	(1)
	H&S CO, H&S BN	(1)
3	MOBILE CONSTRUCTION BN	

FLY-IN ECHELON

MULTIPLE	UNIT		SUB-UNIT MULTIPLE
1	DET MAW HQS (FLY-IN)		
1	MWWU		
2	DET VMFP		
1	VMGR		
3	MAG (VF/VA)		
		H&MS MAG)VF/VA)	(1/1/1)
		VMA (16 A4)	(0/0/2)
		VMA (AW) (11 AGA)	(0/2/0)
		VMFA (12 F4J)	(4/0/0)
		VMA (V) (20 AV-8A)	(0/0/1)

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